FOUNDATIONS COURSE

المحاضرة التأسيسية

ICT, Programming, and AI Basics

Programming Course – Second Year Baccalaureate Students

مادة البرمجة (لغات) – طلاب الصف الثاني بكالوريا
مسار الهندسة وعلوم الحاسب

SESSION 01

Eng. Mahmoud Abdelhamid

Mahmoud Abdelhamed

Programming & AI

Think Clearly. Build Confidently.

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

WHO AM I?

I use programming to solve real engineering problems

Mahmoud Abdelhamid

Water & Environmental Engineer – Hydro-informatics
Cairo University

MSc. Holder • PhD Candidate

- **5+ Years Teaching Experience**
- **Programming, GIS, and Data Analysis Instructor**
- **Certified Data Analyst**

Languages and Tools: Python – JavaScript – HTML – CSS – SQL – R – MATLAB – ArcPy

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Programming matters—even when it is not your job

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WHY THIS MATTERS

1 USE TECHNOLOGY

Work confidently with digital tools

2 UNDERSTAND SYSTEMS

See how Data and AI produce results

3 SOLVE PROBLEMS

Turn complex tasks into testable steps

4 CREATE SOLUTIONS

Automate work and build useful ideas

LOGICAL THINKING travels with you

AUTOMATION saves time and effort

Every field is becoming more connected to Technology, Data, Automation, and AI.

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One strong foundation opens many career paths

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EXPLORE THE DIRECTIONS

DEV

SOFTWARE

Web • Mobile • Games

AI

DATA + AI

Analysis • ML • AI Apps

SEC

CYBER + NETWORKS

Protection • Systems • Connectivity

ENG

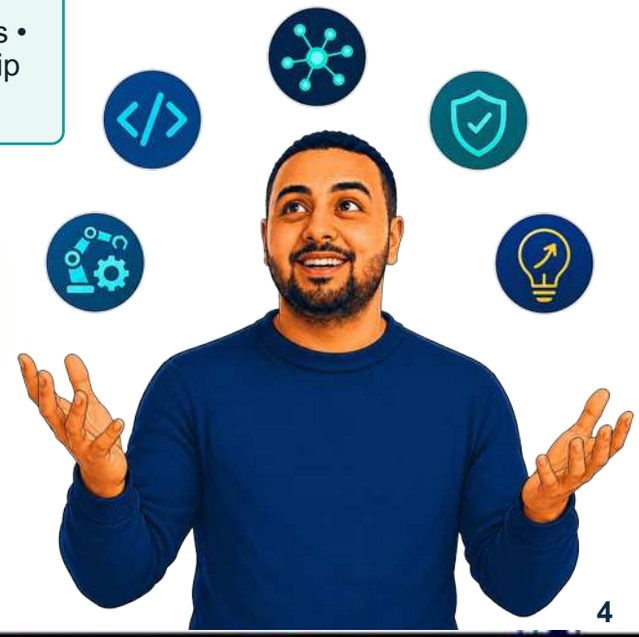
ENGINEERING + AUTOMATION

Robotics • GIS • Scientific Computing

IDEA

DIGITAL PRODUCTS

Tools • Platforms • Entrepreneurship



This course gives you the foundation—not the entire career.

Every direction needs further learning, practice, and projects.

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You learn by watching, thinking, practising, and submitting

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HOW OUR SYSTEM WORKS

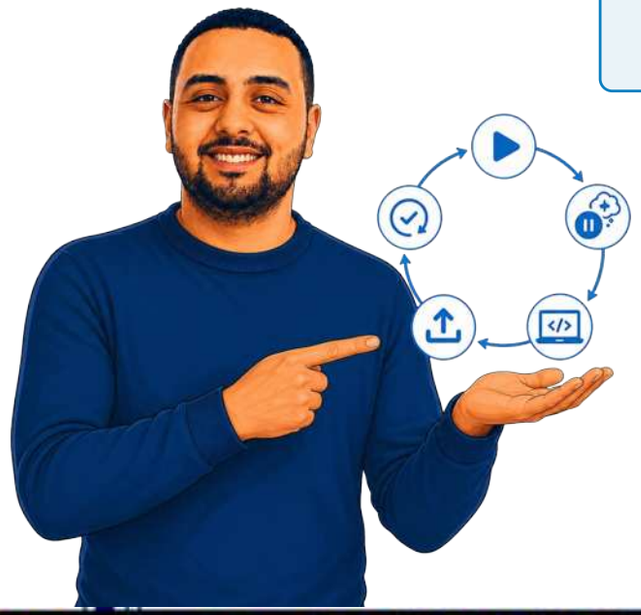
1 — LEARN
Watch the session and follow the example

2 — PAUSE + PREDICT
Answer before the reveal

3 — PRACTISE
Solve exercises and coding tasks

4 — SUBMIT
Submit required work on the platform

5 — REVIEW + IMPROVE
Use feedback, revise, and try again



Recorded does not mean passive—pause, try, make mistakes, then continue.

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Outline

01 Digital Journey
02 Computer Systems
03 Data and Information
04 Network and Web
05 Databases and AI
06 Security and Ethics
07 Algorithms and Flowcharts

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Let's start with the Big Picture

01 Digital Journey

02 Computer Systems

03 Data and Information

04 Network and Web

05 Databases and AI

06 Security and Ethics

07 Algorithms and Flowcharts

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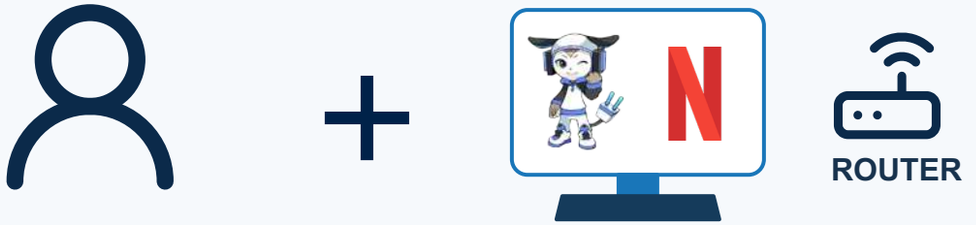
Digital Journey – Big Picture

We'll start with a digital journey you experience every day.

1

1. You are pressing submit for a solution on **Qureo**

(Let's focus on this one for now but we will get to the rest of apps later!)



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Digital Journey – Big Picture

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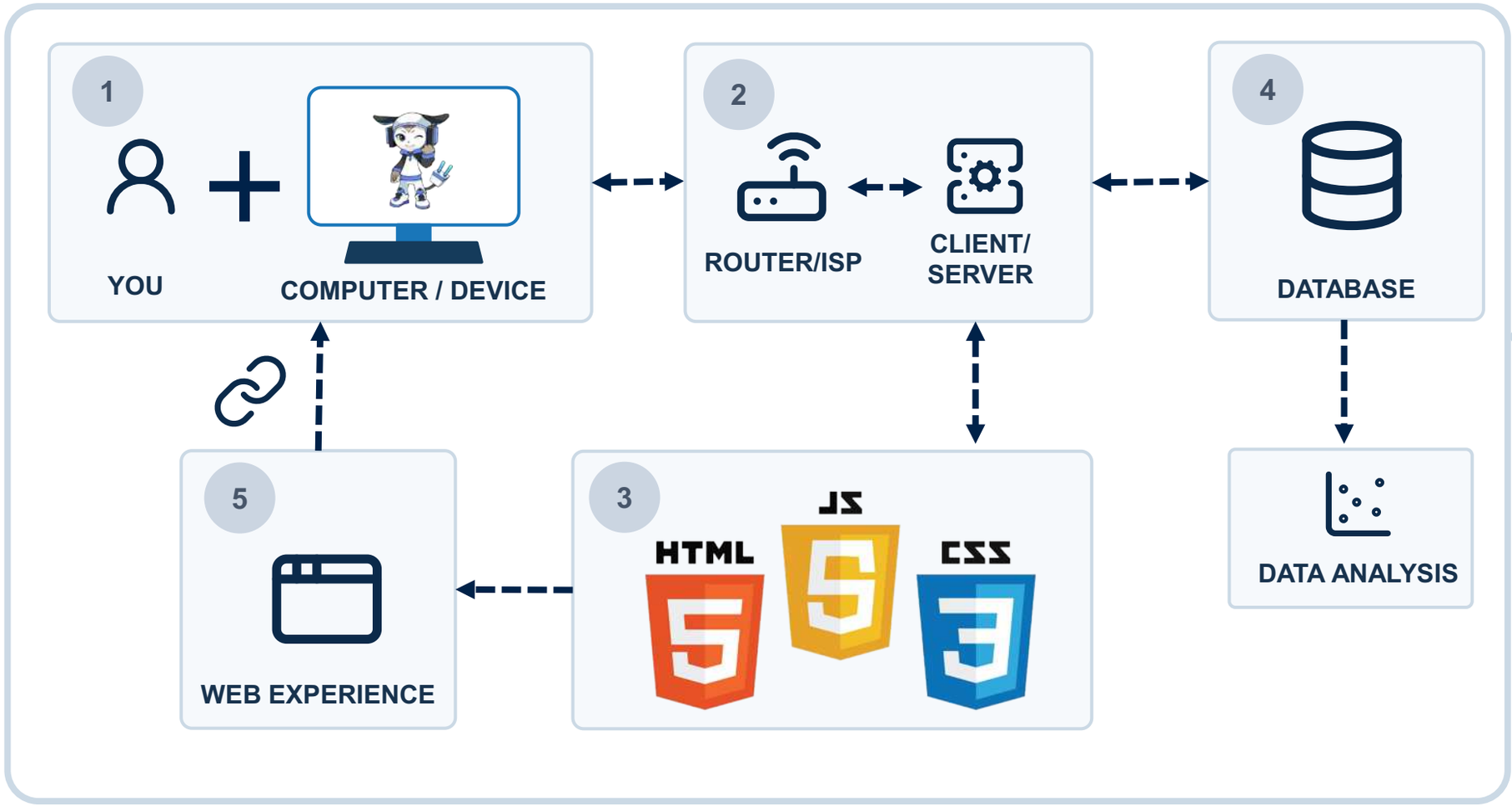

Supports and influences

ACROSS THE DIGITAL JOURNEY

- DATA – INFO – MEDIA – KNOWLEDGE
- ALGORITHMS & PROGRAMMING
- SECURITY & ETHICS
- ARTIFICIAL INTELLIGENCE

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Digital Journey – Big Picture

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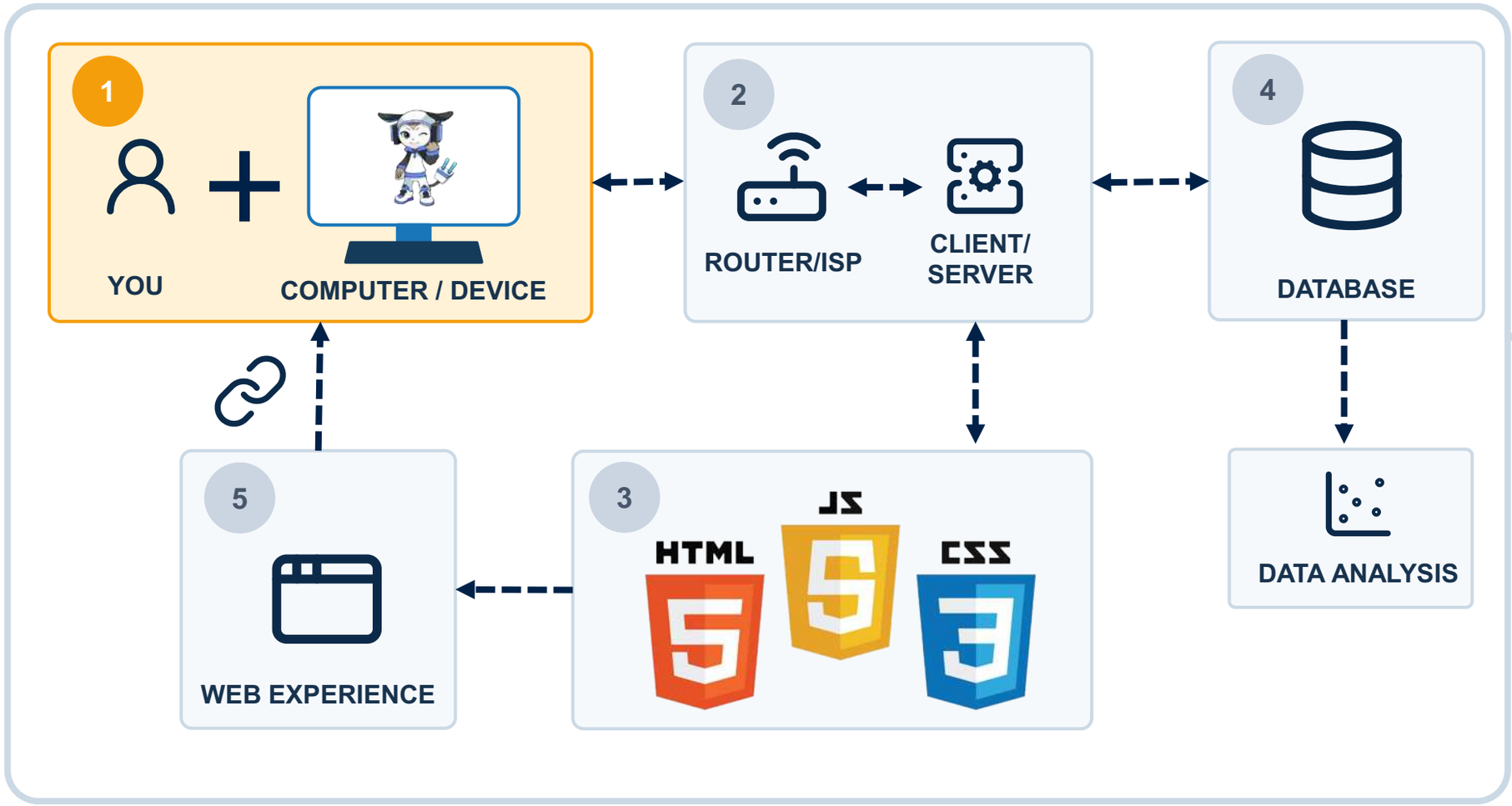

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How does your computer work?

02 Computer Systems

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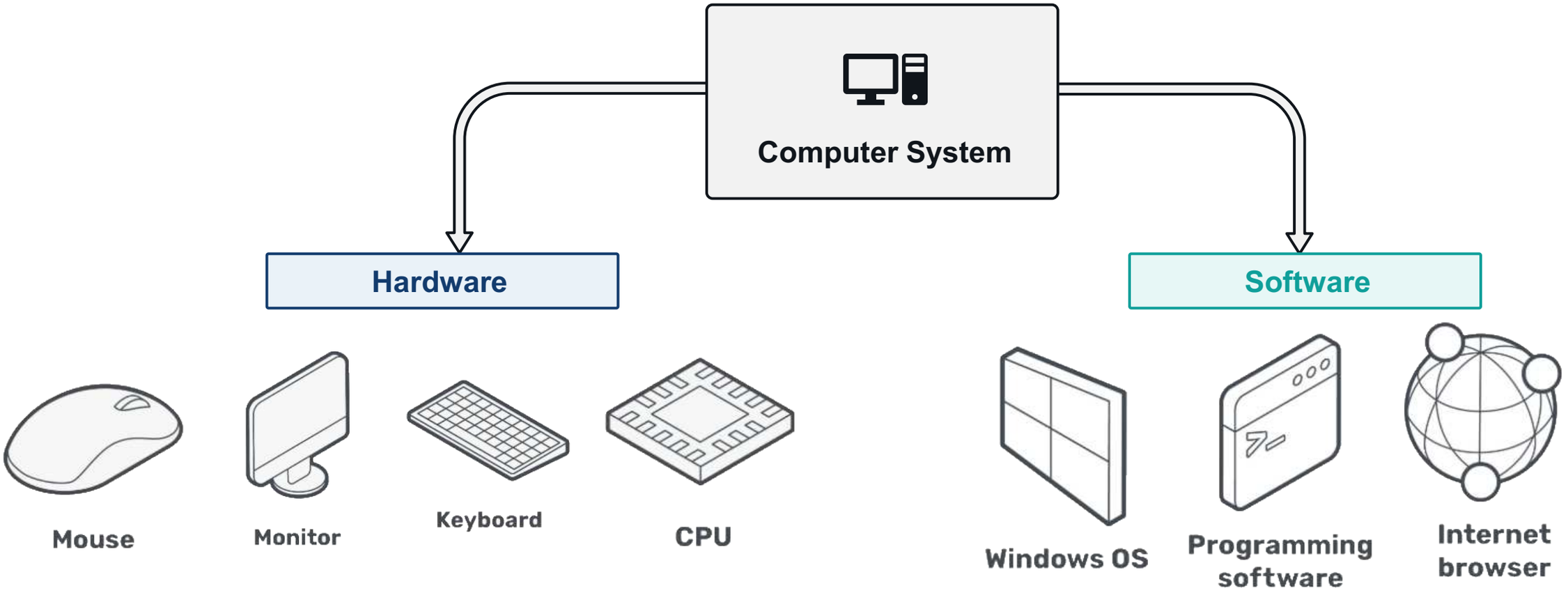
Computer System Components



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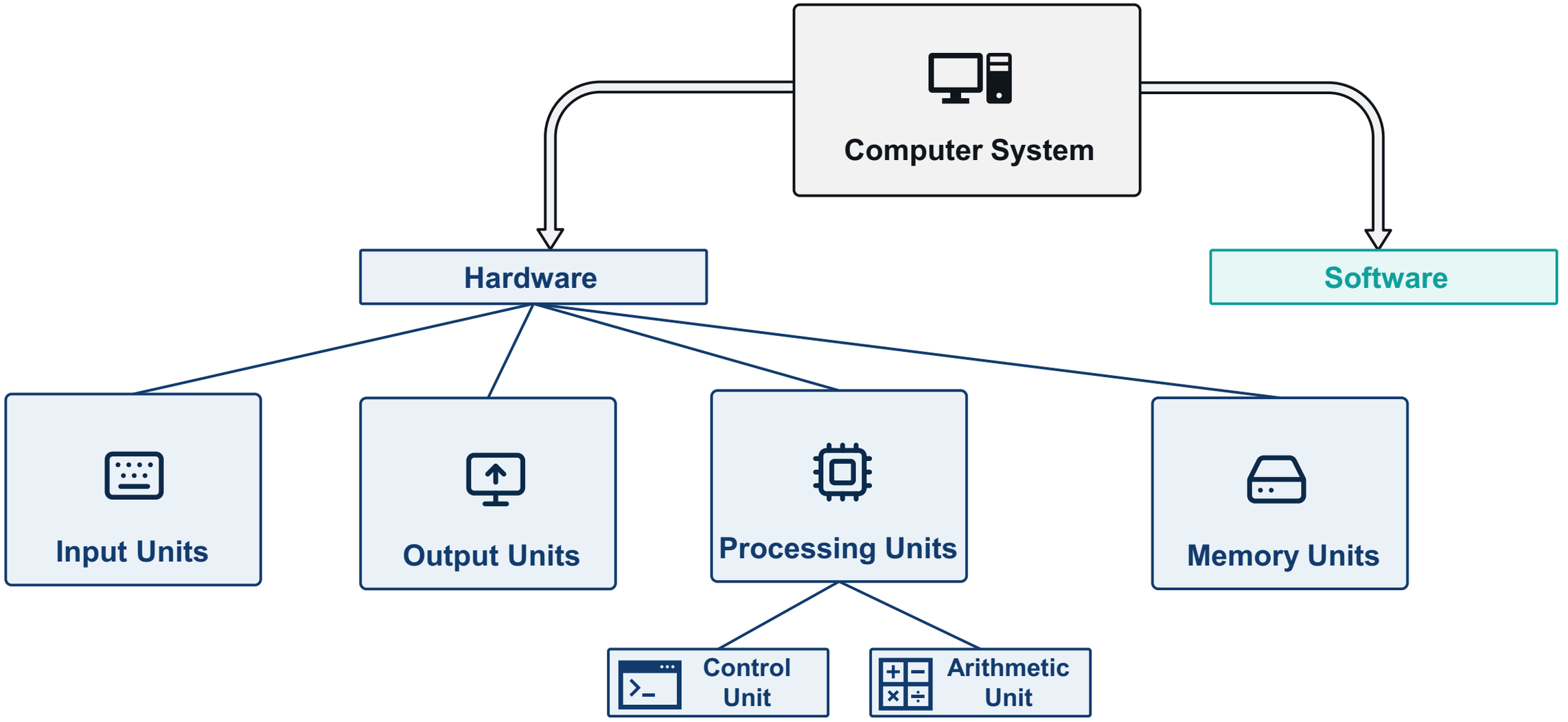
Computer System Components



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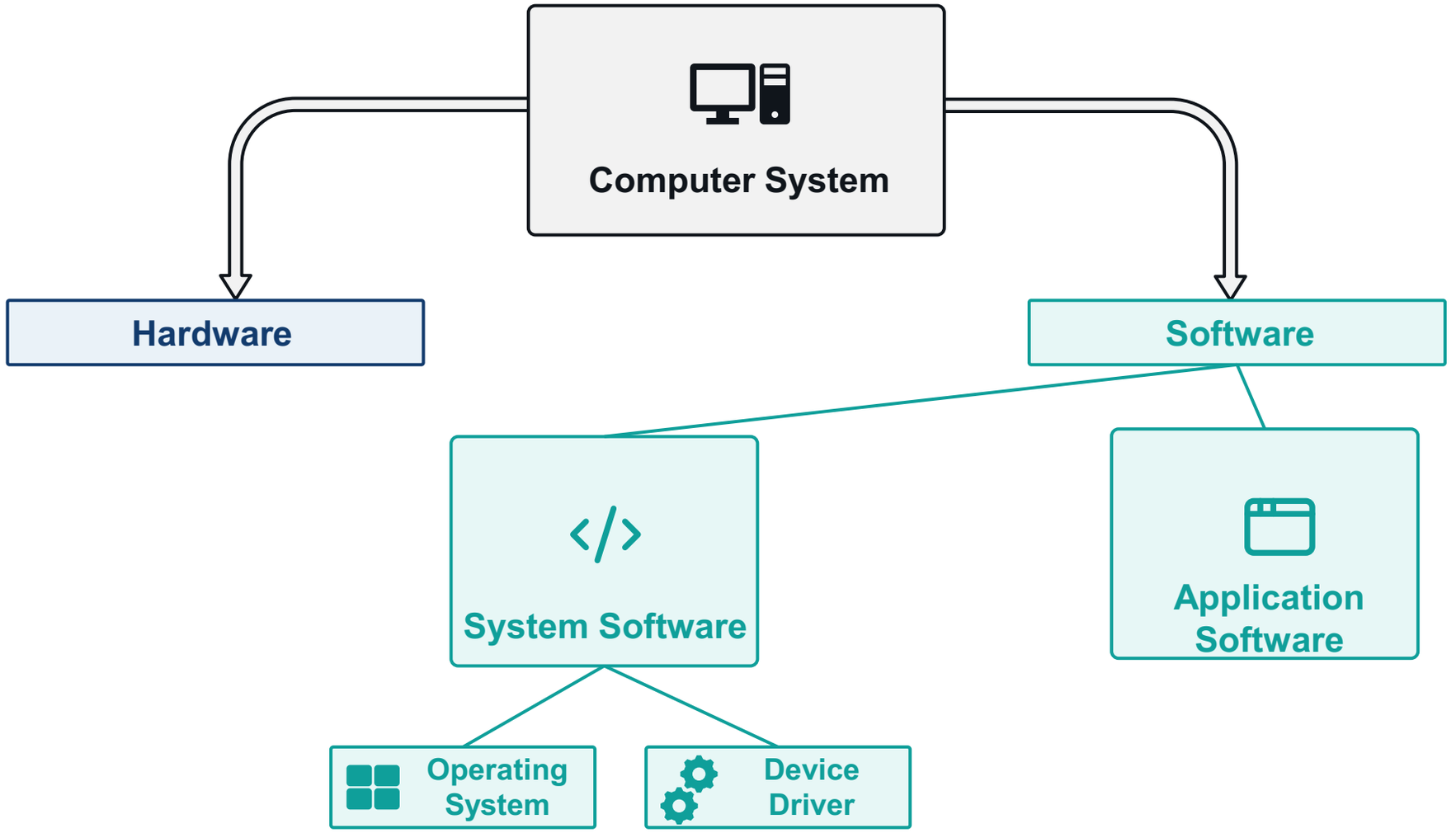

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Computer System Components

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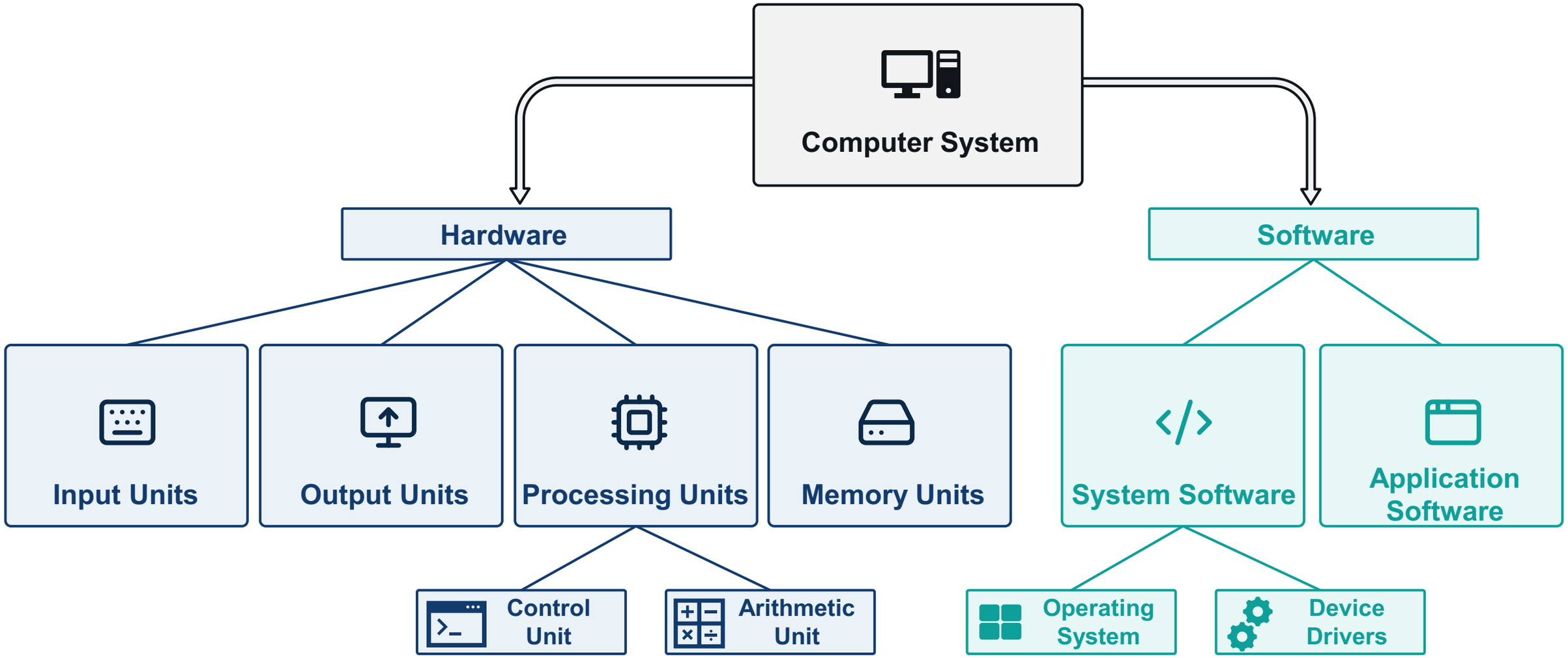

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Interfaces let peripherals exchange information

CONNECT + COMMUNICATE

USB → Keyboard • Mouse • External drive → Peripheral connection

HDMI → Monitor • TV • Audio equipment → Digital video + audio

ETHERNET → Router • Switch • Wired LAN → Network communication

Peripheral = a device connected to the main computer

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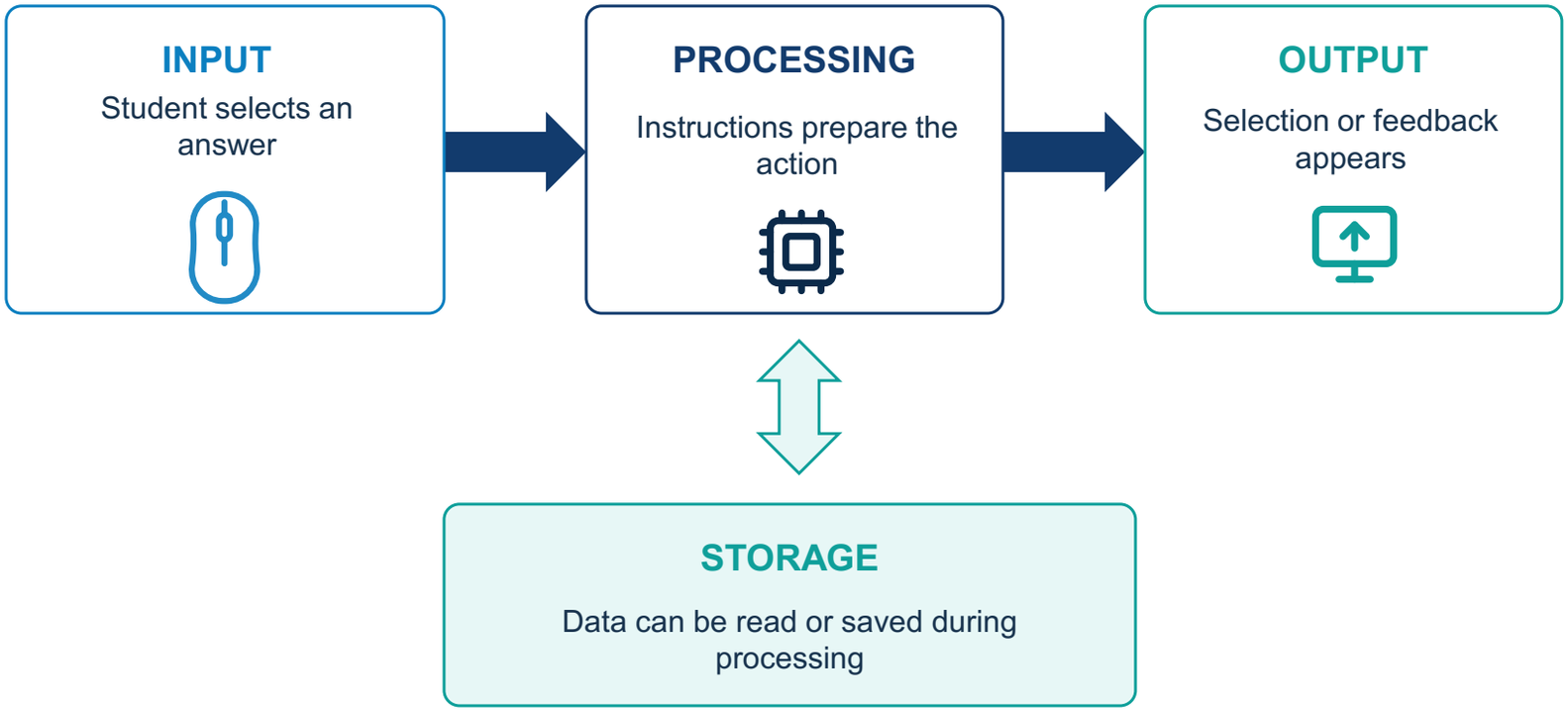
Every action follows the same working cycle

CLICK SUBMIT



Storage is connected to the cycle—it is not always the last step.

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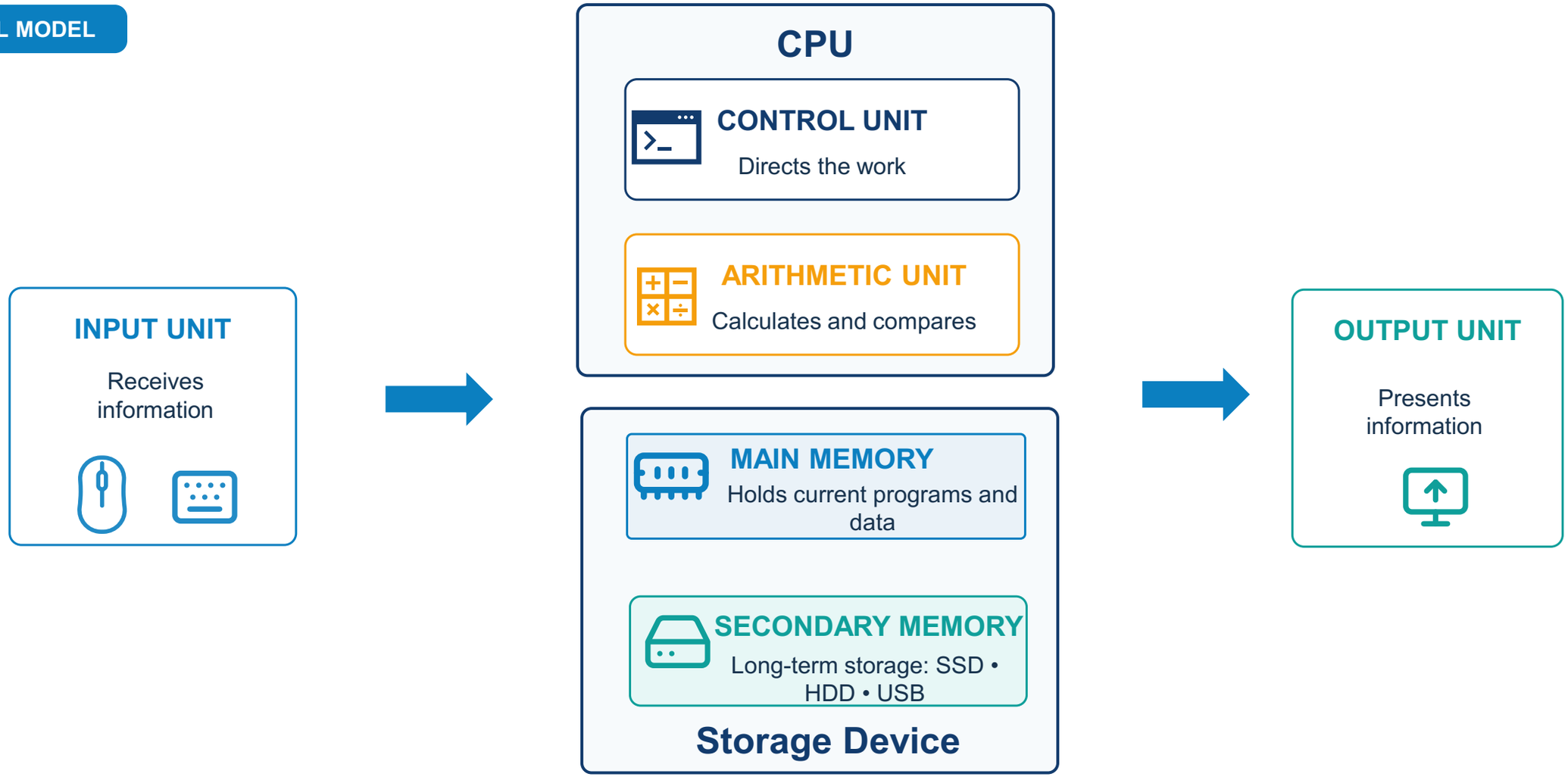
Five components work as one system

OFFICIAL MODEL



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RAM is the desk; storage is the cupboard

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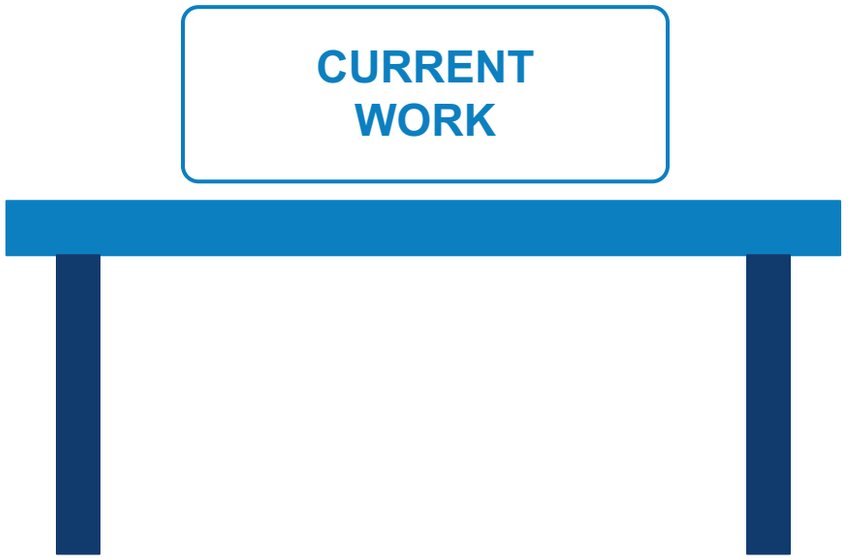
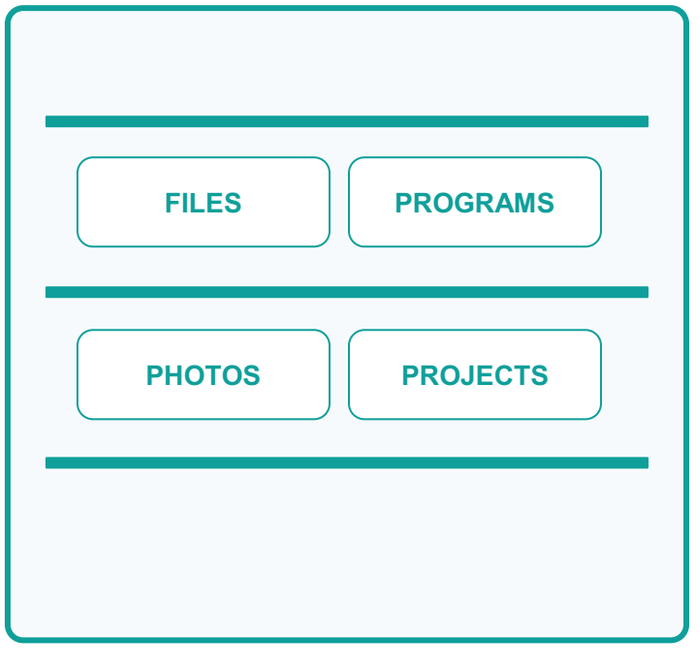
MEMORY ≠ STORAGE

RAM — Main memory



Fast working space • temporary

SSD / HDD — Secondary storage



Keeps data long-term—even after power off

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The Control Unit directs; the ALU calculates

INSIDE THE CPU

CONTROL UNIT — CU

Reads the current instruction

Sends commands to other components

Coordinates what happens next

Directs

ARITHMETIC LOGIC UNIT — ALU

Performs calculations

Compares values

Applies logical operations

Calculates + compares

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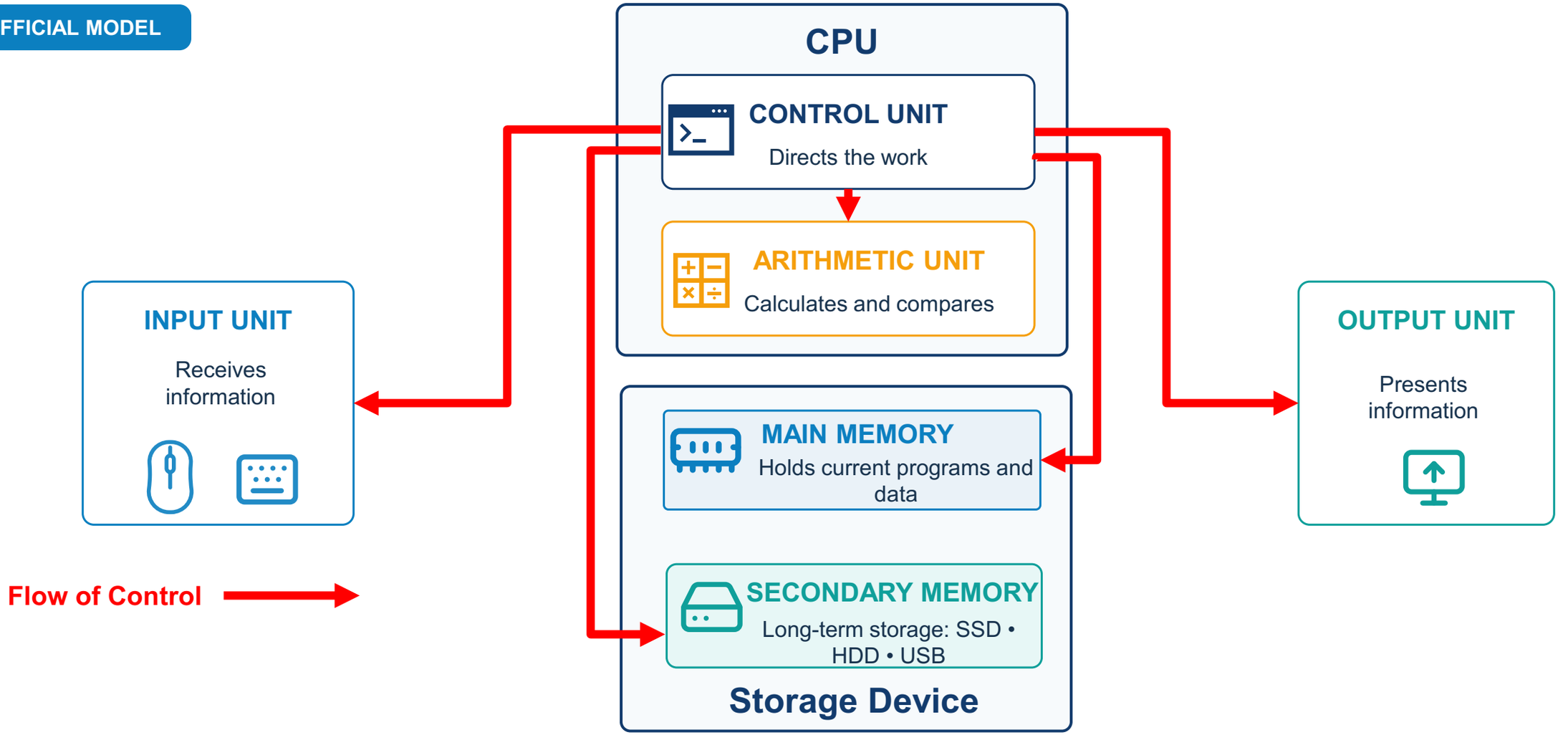
Five components work as one system

OFFICIAL MODEL



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Five components work as one system

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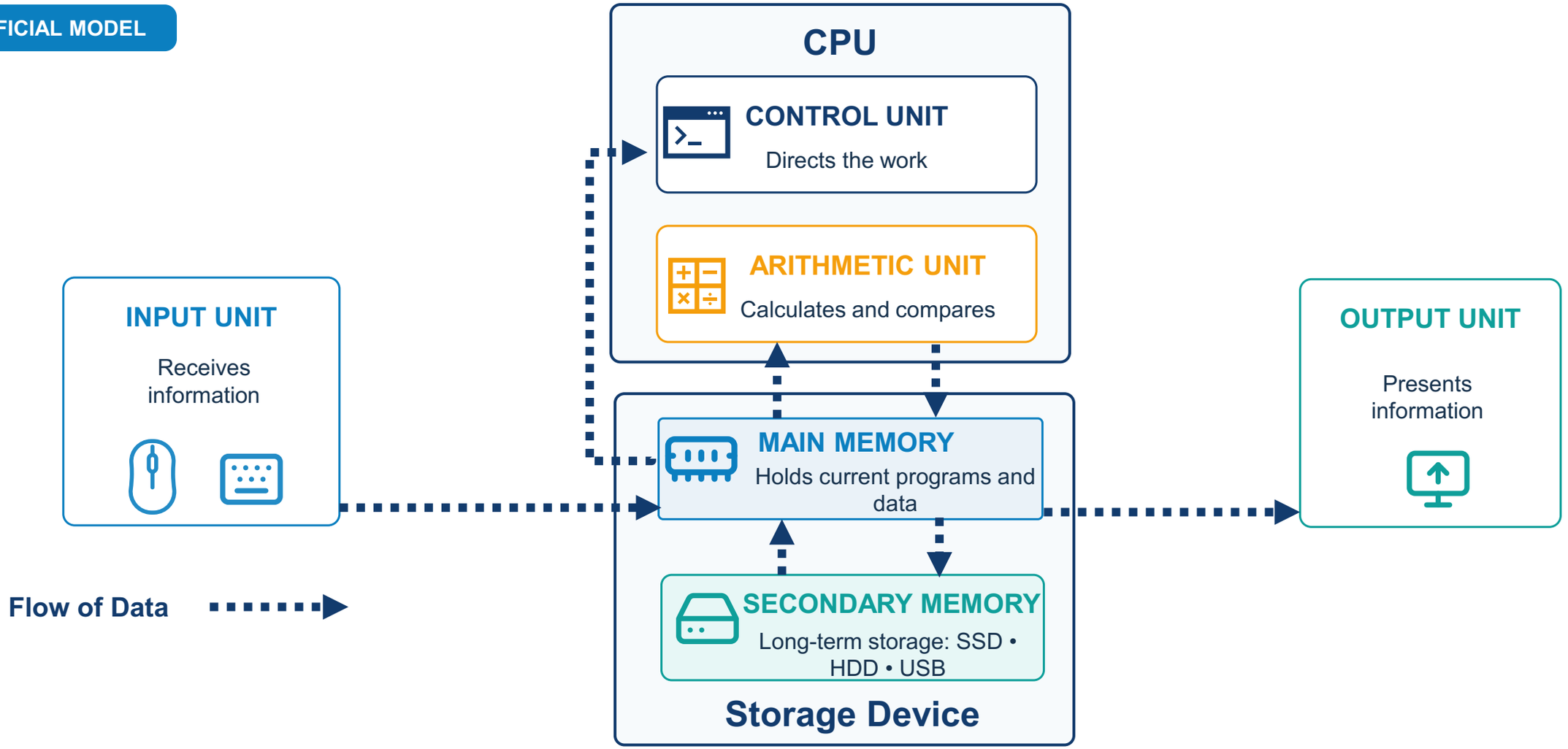

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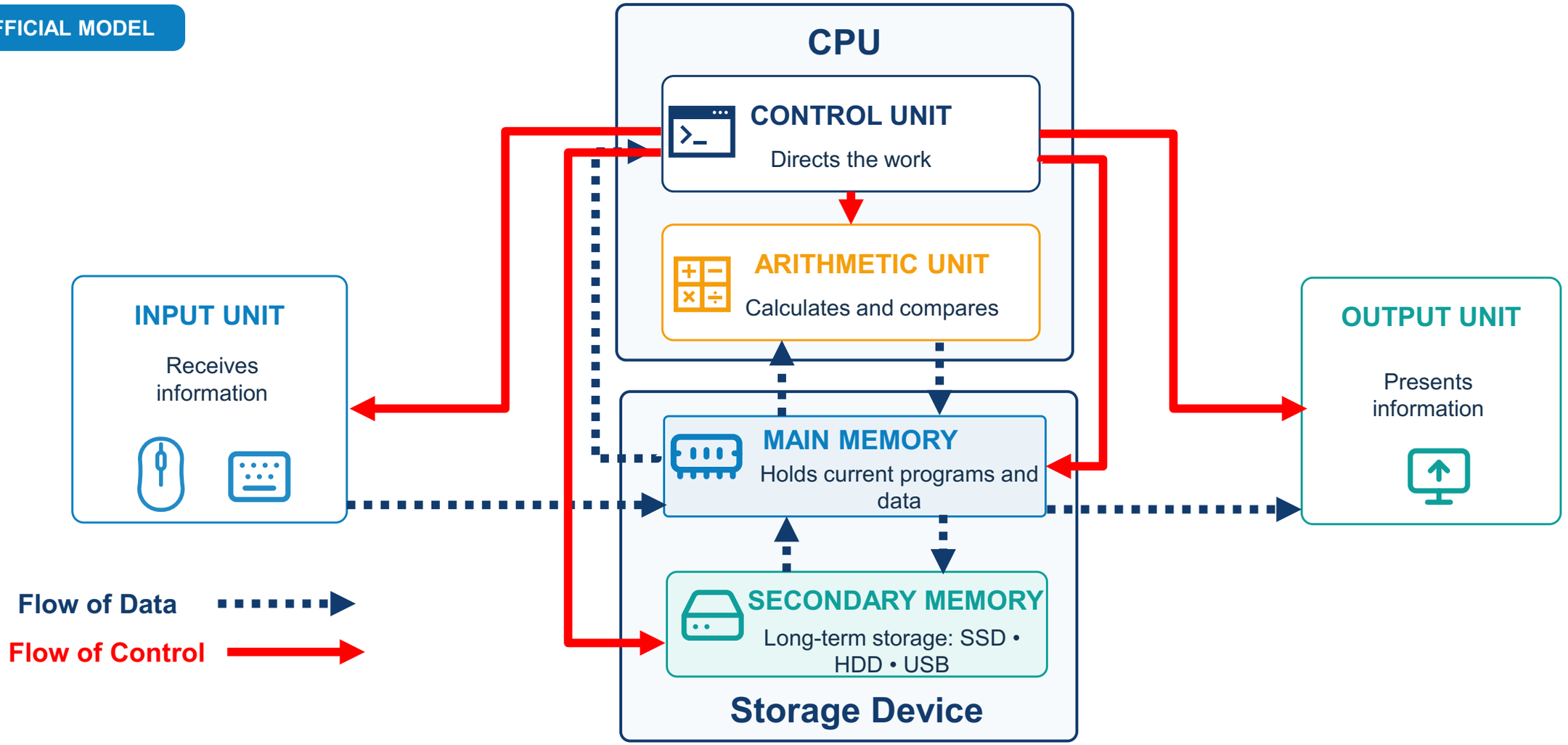
Five components work as one system

OFFICIAL MODEL



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ARITHMETIC LOGIC UNIT — ALU

Performs calculations

Compares values

Applies logical operations

Directs

Calculates + compares

But how does a physical element control or do calculations?

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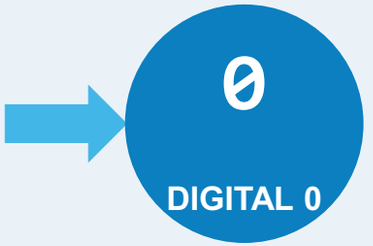
Information begins as two signal states

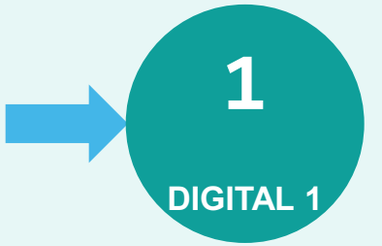
PHYSICAL FOUNDATION

Let’s start from something simple that we know is present in any electronic device which is Signals

LOW voltage range



HIGH voltage range



A digital circuit interprets a signal as one of two states: 0 or 1.

0 does not always mean ‘no electricity’—and 1 does not always mean ‘yes’. Context gives the bits meaning.

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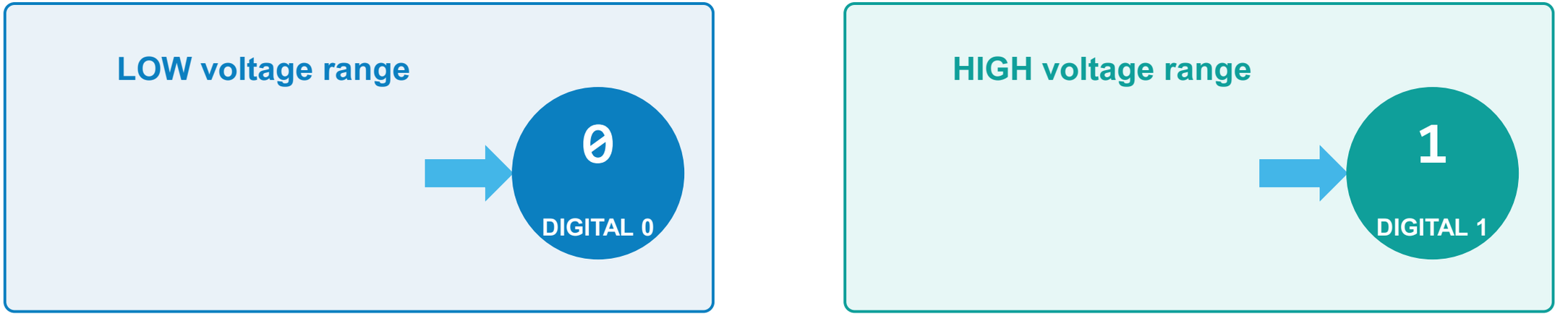
Information begins as two signal states

PHYSICAL FOUNDATION



- Okay, now we know that we have two states which are 0 and 1
- But how does that give us logic, control, and all kinds of outputs we see?
- How can we even control these signals?

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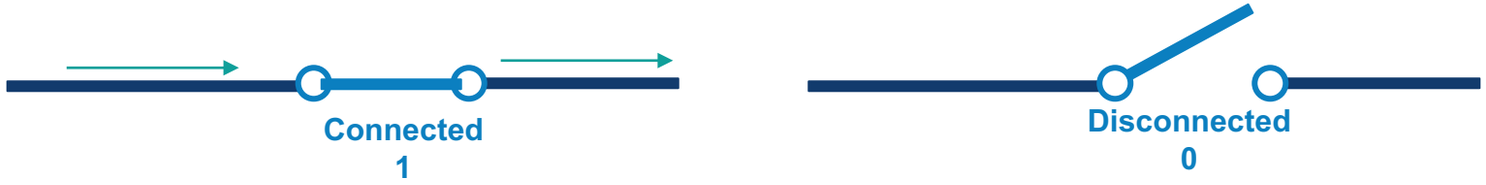
Information begins as two signal states

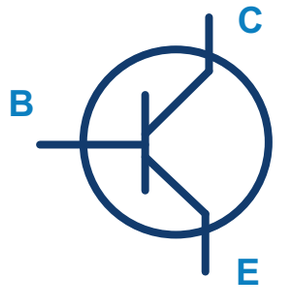
PHYSICAL FOUNDATION

- How can we even control these signals?

Well, how you control electricity at home? Switches!



But not these switches, a digital one, a Transistor!



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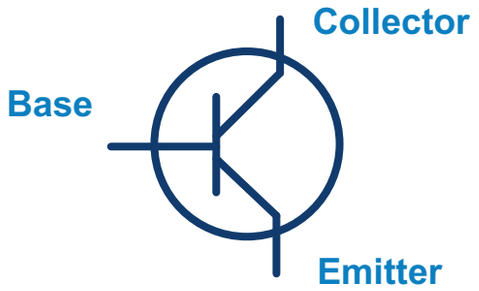
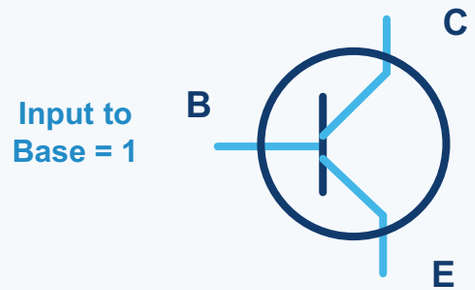
Information begins as two signal states

PHYSICAL FOUNDATION

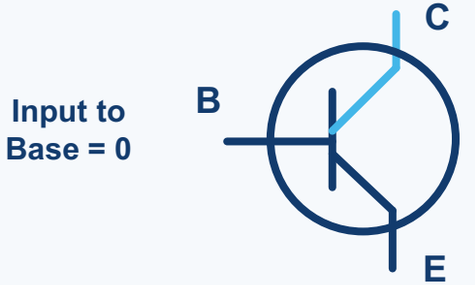
Since this is not a physics class, we will only explain the bare minimum on Transistor – How is it like a digital switch?



Connected



Disconnected



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From a switch to Logic Gates

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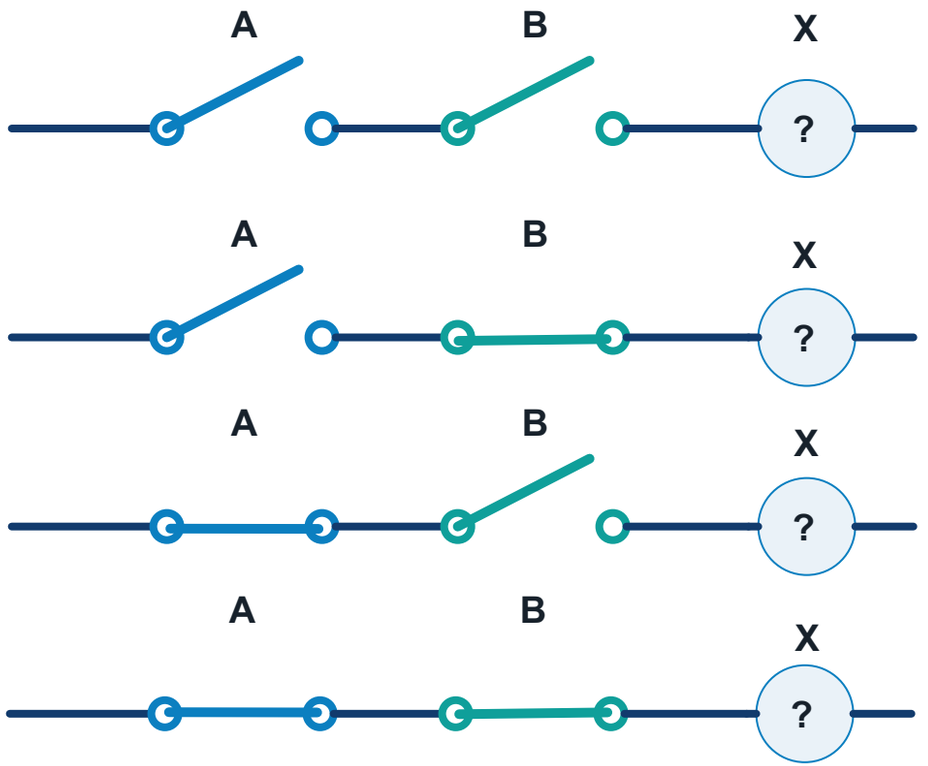
let's get back to the switch analogy just because its more simple

PREDICT THE LAMP



ON

OFF

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From a switch to Logic Gates

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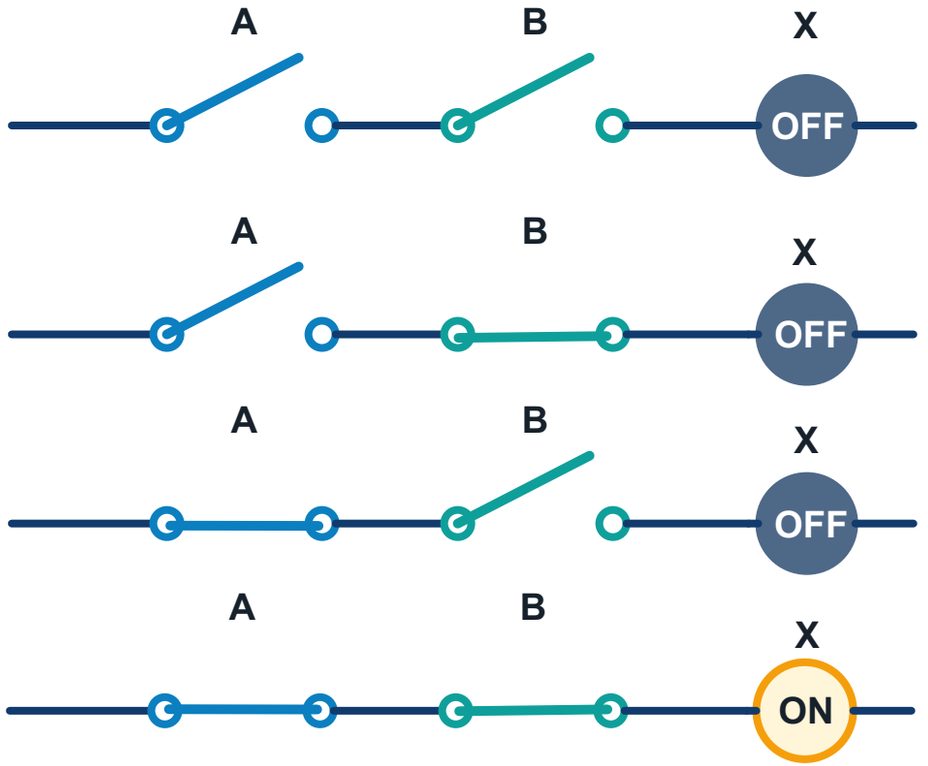

By Abstraction

AND

both inputs = 1

X = A AND B

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

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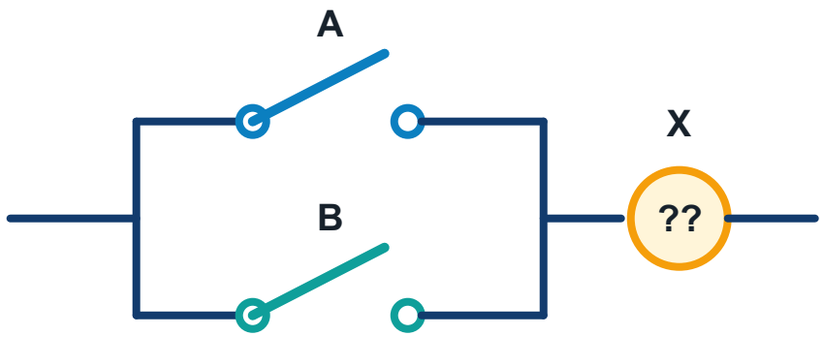
From a switch to Logic Gates

Same concept can be applied to generate multiple logic gates

Try it yourself



By Abstraction

OR

one or both = 1

X = A OR B

A	B	X
0	0	
0	1	
1	0	
1	1	

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From a switch to Logic Gates

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AND

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X = A AND B

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1

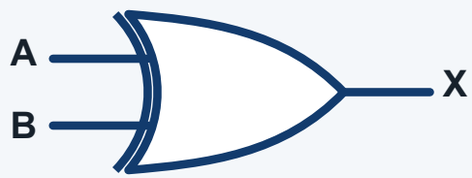
OR

one or both = 1

X = A OR B

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

XOR

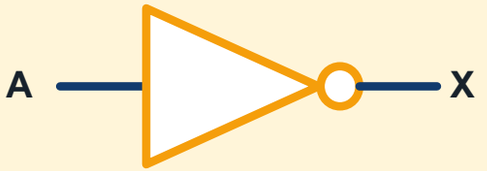


inputs are different

X = A XOR B

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

NOT



reverses A

X = NOT A

A	X
0	1
1	0

A Truth Table lists every possible input combination and its output. If two implementations produce the same table, they perform the same logical rule.

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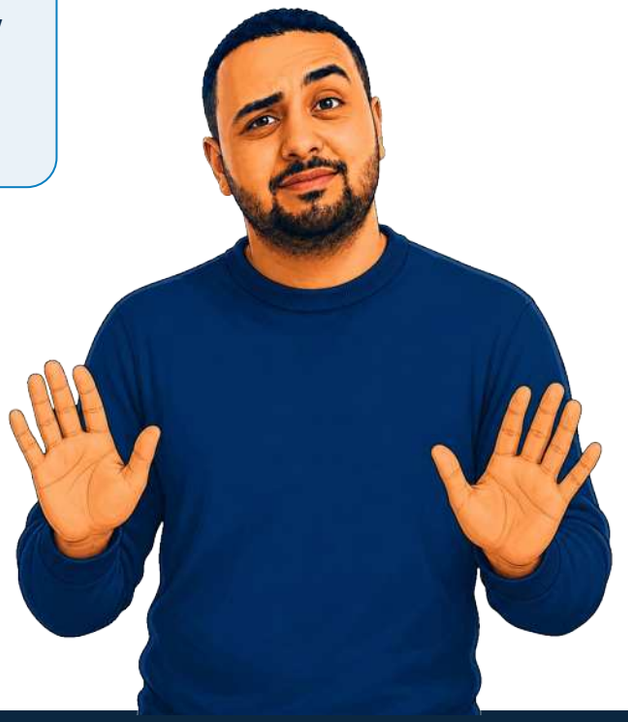
From Logic Gates to Calculations

Okay we got it logic gates and controlling signals but still we need to know how this is turned into an arithmetic calculation, Addition for example



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From Logic Gates to Calculations

Binary Numbers

But before doing so, how can we express all numbers with just 0 and 1?

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From Logic Gates to Calculations

Decimal Numbers

- Normally a decimal number is a number formed using 10 digits: 0 → 9
- So, for a slot we have numbers from 0 to 9 which are 10^1 numbers
- And for 2 slots we can have numbers from 00 to 99 which is 10^2 numbers

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Binary Numbers

- In binary, a single slot is "bit" and it can only have 0 or 1 which means it can represent 2 numbers only in this case 0 and 1
- A 2-bit binary can have 2^2 = 4 possibilities which are "00 , 01 , 10 , 11"
- An 8-bit "byte" binary can have 2^8 = 256 possibilities meaning it can present numbers from 0 → 255 but a 0 would look like 00000000 and a 255 would look like 11111111 so what is the rule to interpret binary numbers ?

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Binary Numbers

What is the rule to interpret binary numbers ?

WEIGHT $2^3 = 8$	WEIGHT $2^2 = 4$	WEIGHT $2^1 = 2$	WEIGHT $2^0 = 1$
0	1	0	1
+ 0	+ 4	+ 0	+ 1

$$0101_2$$
$$= 0 + 2^2 + 0 + 2^0$$
$$= 0 + 4 + 0 + 1$$
$$= 5_{10}$$

Binary	Weight = $2^3 = 8$	Weight = $2^2 = 4$	Weight = $2^1 = 2$	Weight = $2^0 = 1$	Decimal
0000	0	0	0	0	0
0001	0	0	0	1	1
0010	0	0	1	0	2
0011	0	0	1	1	3
0100	0	1	0	0	4
0101	0	1	0	1	5
0110	0	1	1	0	6
0111	0	1	1	1	7
1000	1	0	0	0	8
1001	1	0	0	1	9
1010	1	0	1	0	10
1011	1	0	1	1	11
1100	1	1	0	0	12
1101	1	1	0	1	13
1110	1	1	1	0	14
1111	1	1	1	1	15

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Binary Numbers

The rule is simple whatever the number of bits is!

$$01010011_2$$

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Binary Numbers

The rule is simple whatever the number of bits is!

PLACE VALUE

$2^7 = 128$	$2^6 = 64$	$2^5 = 32$	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$	
0	1	0	1	0	0	1	1	$_2$

Each position is worth twice the position to its right.

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Binary Numbers

Each 1 adds its place value; each 0 adds nothing

1 Label the bits with powers of 2, starting from 2^0 on the right

Place value	$2^7 = 128$	$2^6 = 64$	$2^5 = 32$	$2^4 = 16$	$2^3 = 8$	$2^2 = 4$	$2^1 = 2$	$2^0 = 1$	
Binary digit	0	1	0	1	0	0	1	1	$_2$

2 Multiply each bit by its place value

0 × 128 = 0	**1 × 64 = 64**	0 × 32 = 0	**1 × 16 = 16**	0 × 8 = 0	0 × 4 = 0	**1 × 2 = 2**	**1 × 1 = 1**

3 Add the products

$$0 + 64 + 0 + 16 + 0 + 0 + 2 + 1 = 83_{10}$$

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Decimal to Binary

Method 1: Repeated division is systematic and always works

1 Start with 83_{10}; divide each quotient by 2 until it reaches 0

Divide by 2	Quotient	Remainder
83 ÷ 2	41	**1**
41 ÷ 2	20	**1**
20 ÷ 2	10	**0**
10 ÷ 2	5	**0**
5 ÷ 2	2	**1**
2 ÷ 2	1	**0**
1 ÷ 2	0	**1**

2 Read the remainders from bottom to top

1	0	1	0	0	1	1

1010011_2

The last remainder becomes the first bit.

3 Need 8 bits? Add a leading zero

$01010011_2 = 83_{10}$

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Decimal to Binary

Method 2: Powers of 2 are often faster for small numbers

1 **Start with 83 and scan the place values from left to right**

If the value fits the current remainder: write 1 and subtract it. Otherwise: write 0.

Place value	128	64	32	16	8	4	2	1
Does it fit?	No	**Yes**	No	**Yes**	No	No	**Yes**	**Yes**
Write bit	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**1**
Remainder	83	19	19	3	3	3	1	0

2 **Subtract only the values marked 1 until the remainder reaches 0**

83 − 64 = 19 → 19 − 16 = 3 → 3 − 2 = 1 → 1 − 1 = 0

$$01010011_2$$

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Practice Time!

Convert the following numbers:

- 241_{10}
- 128_{10}
- 10101010_2
- 10010011_2

Without conversion, is this number even or odd:

$$101110101010110101001101012$$

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Binary Numbers

Now half problem solved! But still how to make addition to binary?

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Decimal Numbers

- In decimal numbers the addition was like this for each slot we have output and possible carry since the digits in any slot should be from 0 → 9 a value above 9 is not suitable for that slot and should be carried to next slot!

```
  7 9
+ 0 1
-----
  8 0
```


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Binary Numbers

- The binary numbers work the exact same way ! Except that each slot can take 0 or 1 so a value above 1 should be carried to higher slot!

```
  0 1 1 1
+ 0 0 0 1
---------
1 0 0 0
```


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From Logic Gates to Calculations

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Binary Numbers

```
  0 1 0 1
+ 1 1 1 0
---------
```

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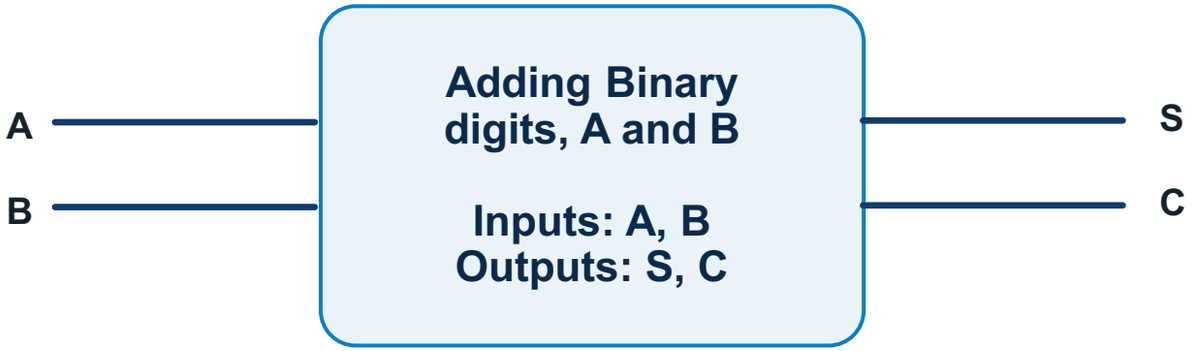
Half Adder

- Now back to addition! Let's start by a simple adder
- We have 2 1-bit binary numbers A and B
- When adding them we should get a result S and a carry C



The expected response

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

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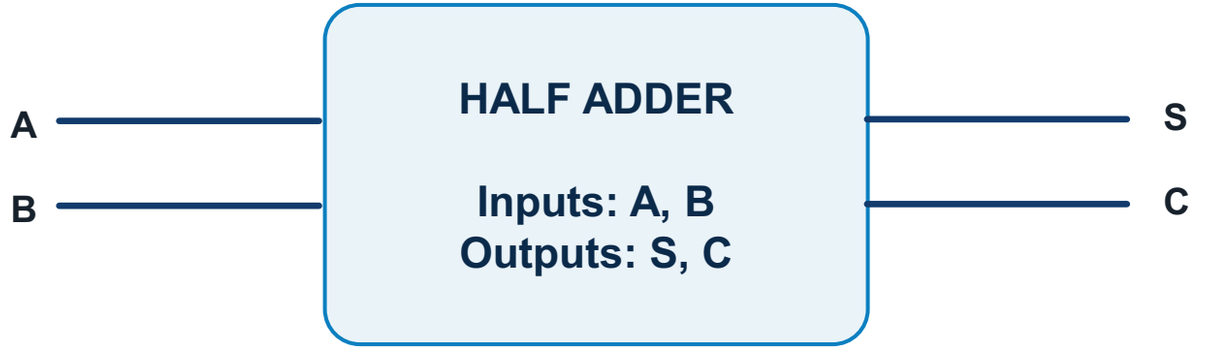
Half Adder

I think I have seen these tables before



HALF ADDER TRUTH TABLE

A	B	S
0	0	0
0	1	1
1	0	1
1	1	0

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

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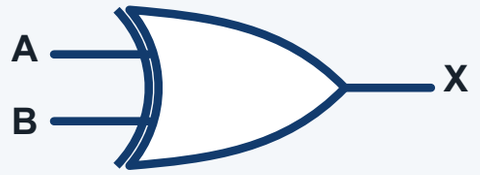
Half Adder

A	B	S	
0	0	0	
0	1	1	
1	0	1	
1	1	0	

A	B		C
0	0		0
0	1		0
1	0		0
1	1		1

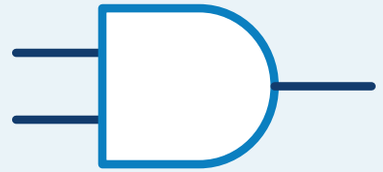
XOR



inputs are different

X = A XOR B

AND



both inputs = 1

X = A AND B

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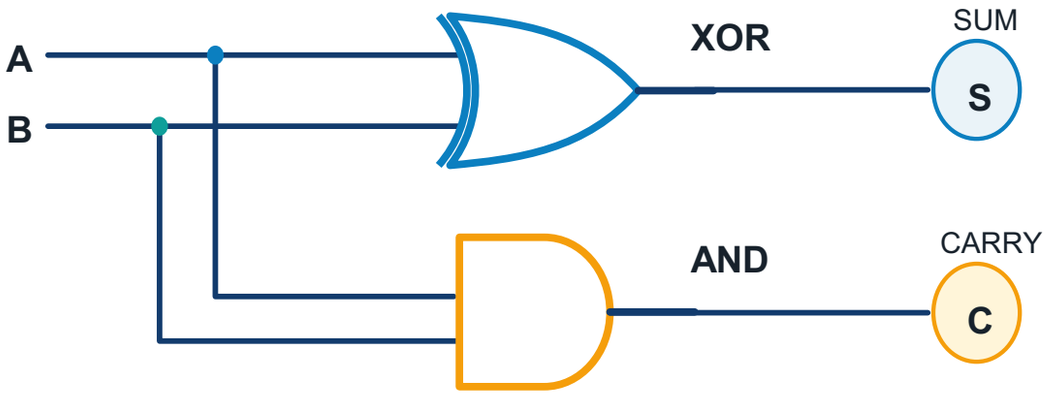
From Logic Gates to Calculations

Half Adder



A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Simply the mysterious half adder we need is just two gates AND - XOR

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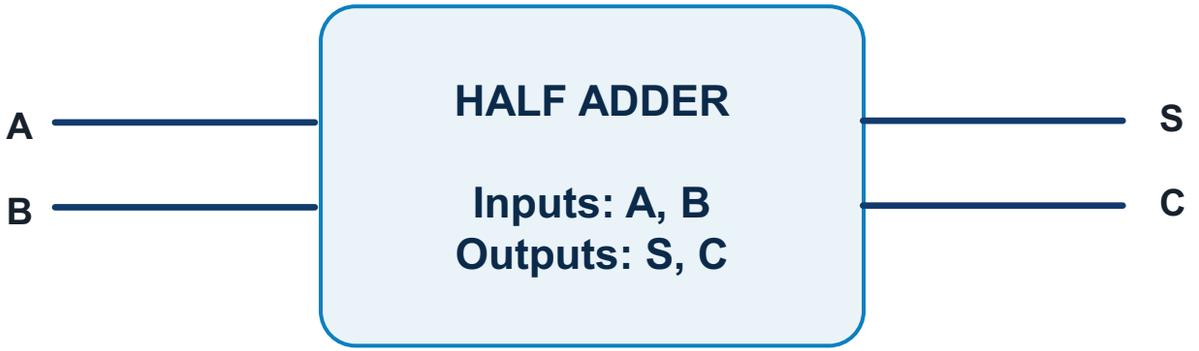
From Logic Gates to Calculations

Half Adder



HALF ADDER TRUTH TABLE

A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Again, with Abstraction we can name it as one unit called Half Adder

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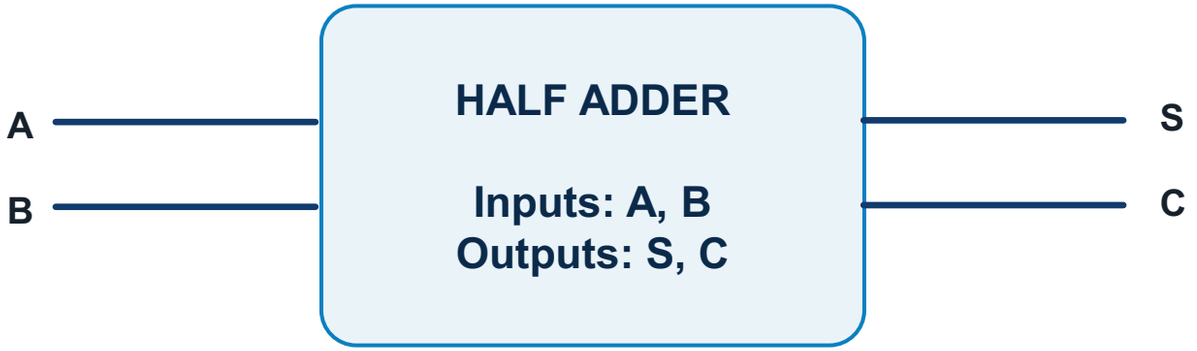
Full Adder



So, we have our adder but why is it half adder? Well remember the carried value? We didn't assign it anywhere so even if we use 8 half adders, we can't perform addition on 8-bits binary numbers

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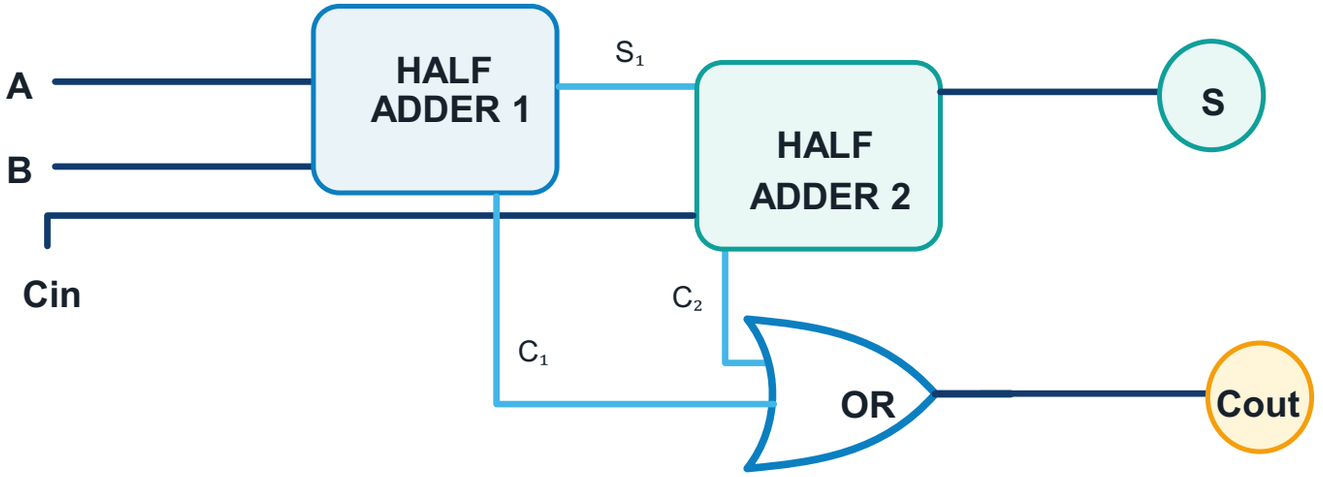
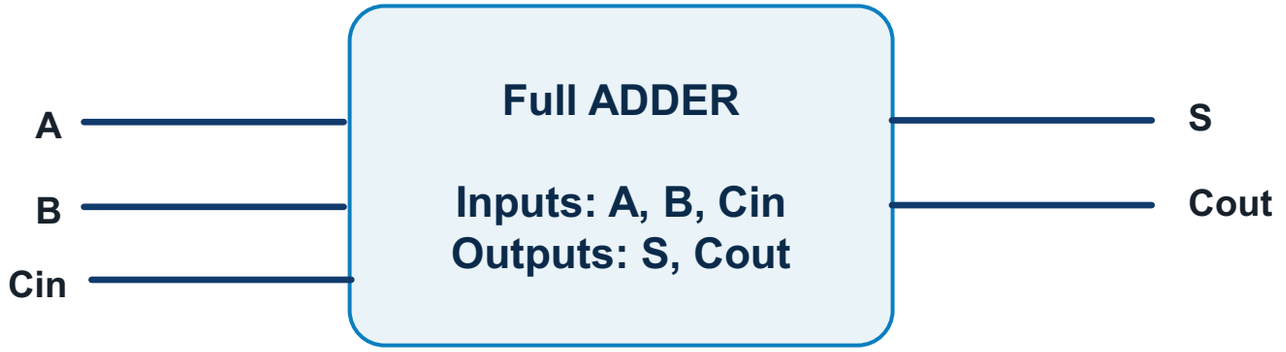
From Logic Gates to Calculations

Full Adder



By Abstraction



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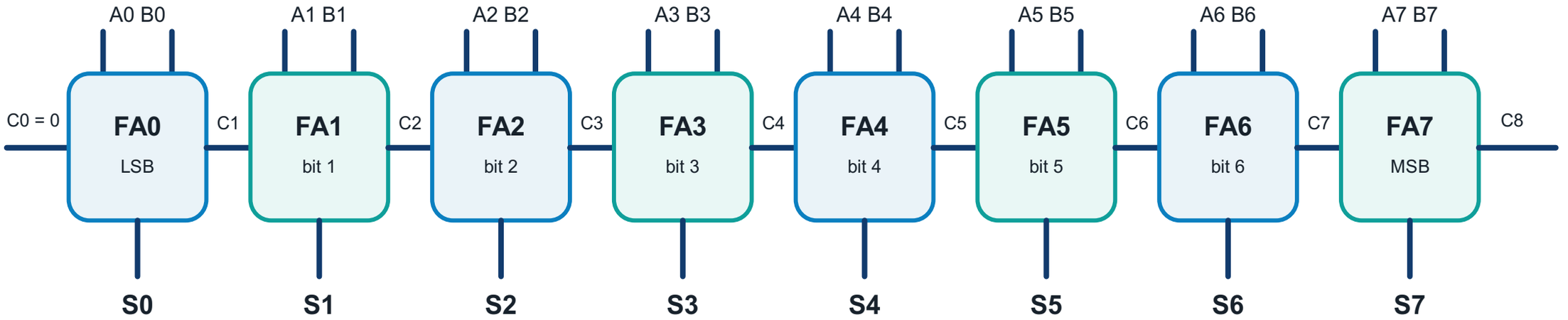
From Logic Gates to Calculations

8-bits Adder



Each Carry-out becomes the next Carry-in.

$$00001111_2 + 00000001_2 = 00010000_2$$

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Computer System Components

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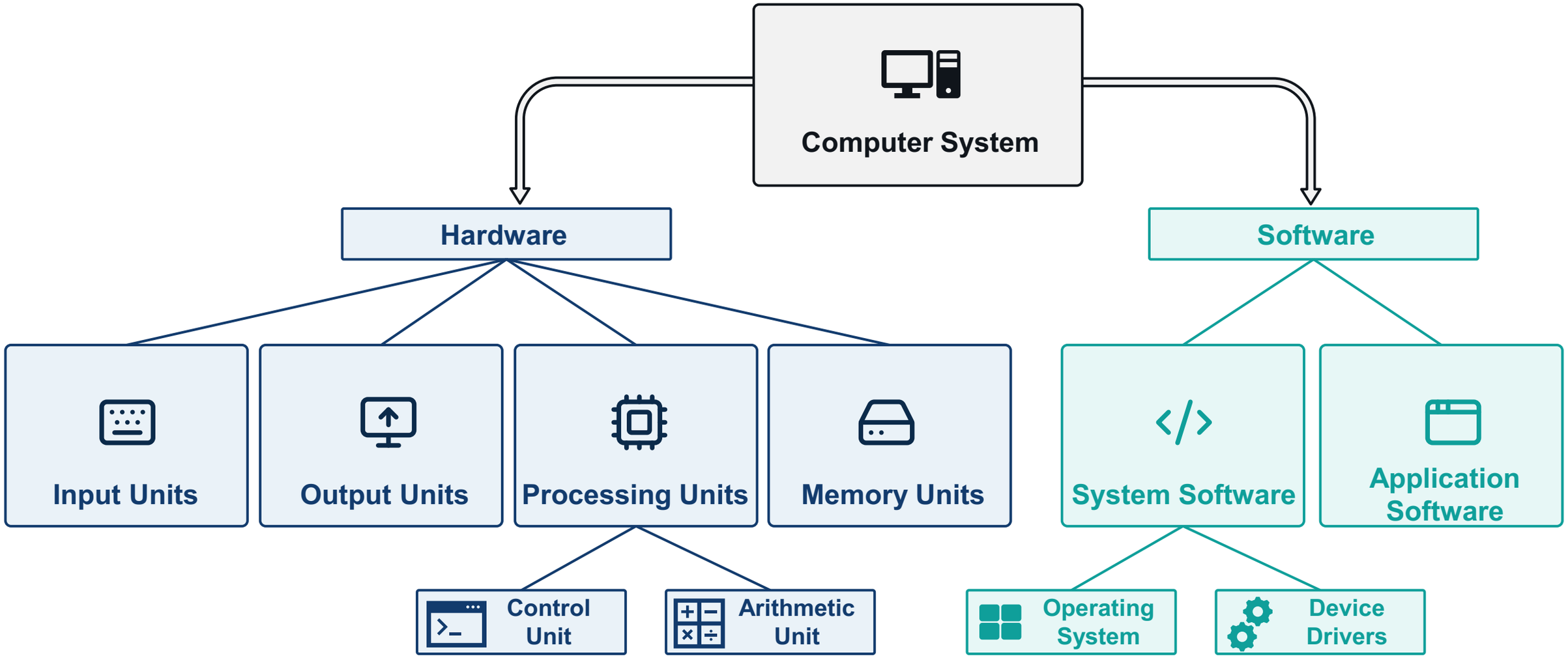

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Digital Journey – Big Picture

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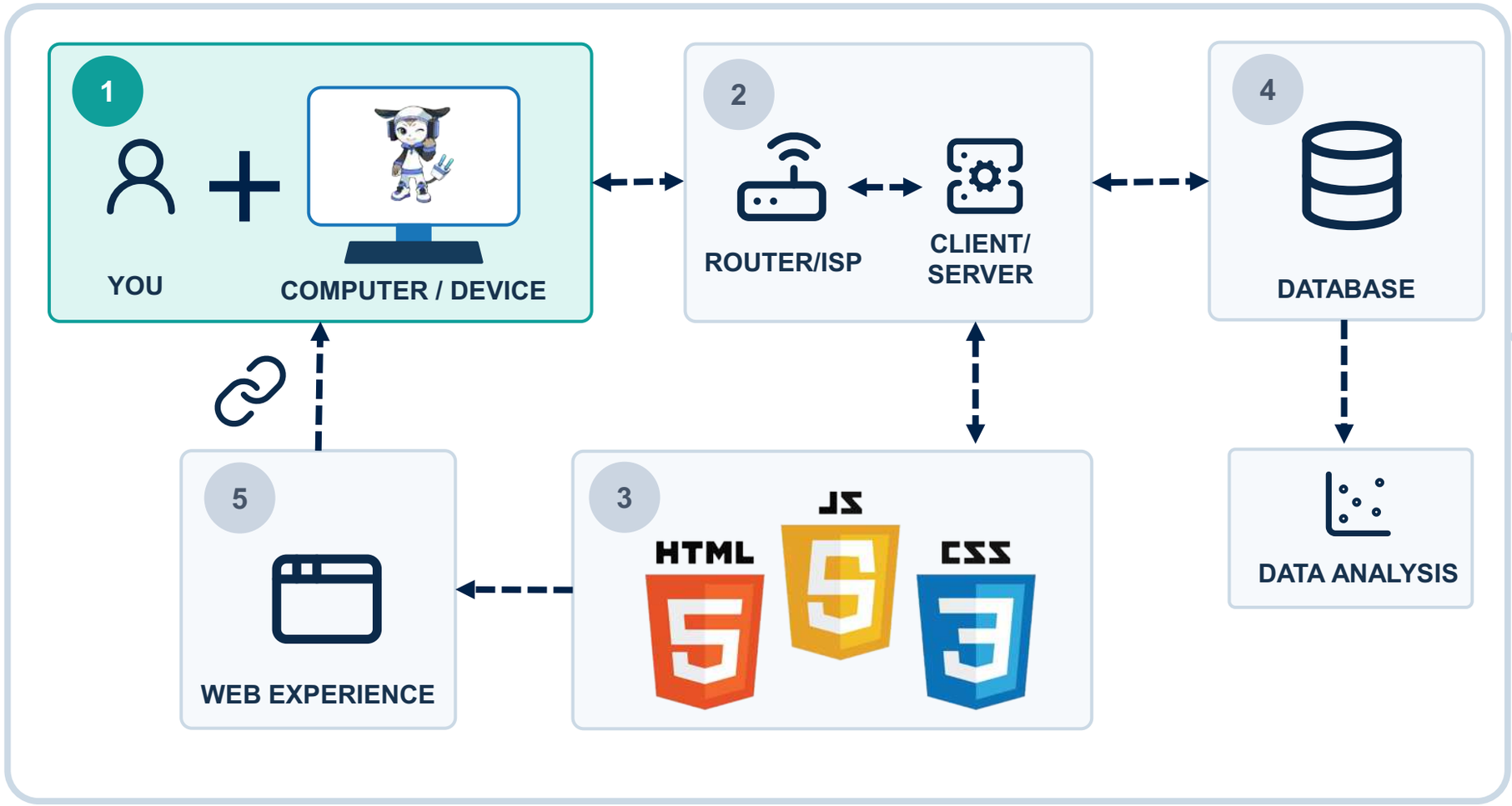

Supports and influences

ACROSS THE DIGITAL JOURNEY

- DATA – INFO – MEDIA – KNOWLEDGE
- ALGORITHMS & PROGRAMMING
- SECURITY & ETHICS
- ARTIFICIAL INTELLIGENCE

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QUESTION 1 / 9

Which item is hardware?

A Operating system

B Keyboard

C Internet browser

D Programming application

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Quick Check — Computer Systems

QUESTION 2 / 9

Which item is system software?

A A presentation file

B A web page

C An operating system

D A student’s JavaScript program

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Quick Check — Computer Systems

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QUESTION 3 / 9

Which order best describes what happens after a student chooses an answer and sees feedback?

A Output → Input → Processing

B Input → Processing → Output

C Storage → Output → Input

D Processing → Input → Storage

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QUESTION 4 / 9

Which statement about the CPU is correct?

A The CU calculates while the ALU stores files.

B The CU directs operations while the ALU calculates and compares.

C RAM controls every input device.

D The SSD performs logical operations.

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QUESTION 5 / 9

Which statement best describes RAM?

A Long-term storage that keeps data after power is off

B Current working memory that is normally volatile

C An output unit

D Application software

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QUESTION 6 / 9

When does an AND gate output 1?

A When both inputs are 0

B When at least one input is 1

C When both inputs are 1

D When the inputs are different

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QUESTION 7 / 9

What is the decimal value of 0101_2?

A 4

B 5

C 8

D 10

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Quick Check — Computer Systems

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QUESTION 8 / 9

What is $0111_2 + 0001_2$?

A 0110_2

B 1000_2

C 1111_2

D 0000_2

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Quick Check — Computer Systems

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QUESTION 9 / 9

Why is a full adder needed after the least-significant bit?

A It stores data permanently.

B It converts decimal directly to text.

C It accepts the carry-in from the previous bit.

D It sends the result to the monitor.

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Quick Check — Answer Key

ANSWER KEY

Check the idea—not only the letter.

1 · B
Keyboard is physical hardware.

2 · C
The OS manages the computer.

3 · B
Input → Processing → Output.

4 · B
CU directs; ALU calculates.

5 · B
RAM holds current work.

6 · C
AND needs 1 and 1.

7 · B
$0101_2 = 5_{10}$.

8 · B
$0111_2 + 0001_2 = 1000_2$.

9 · C
A full adder accepts carry-in.

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آخر 10 دقايق | LEVEL UP

تعالى نتكلم شوية

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Learning

How to learn efficiently?

AI and Productivity

How to turn AI into your

Habits

How to survive in the age

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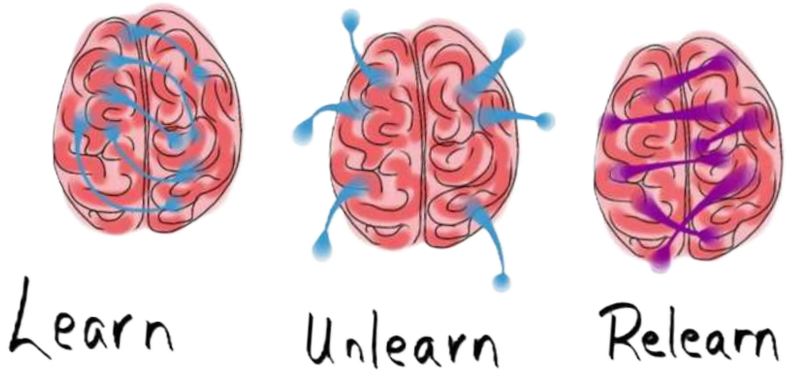
LEVEL UP #01: LEARN • UNLEARN • RELEARN

"The illiterate of the 21st century will not be those who cannot read and write, but those who cannot **learn**, **unlearn**, and **relearn**."

— Commonly attributed to Alvin Toffler

Alvin Toffler



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Thank you!

Hope you enjoyed the session!

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Contacts

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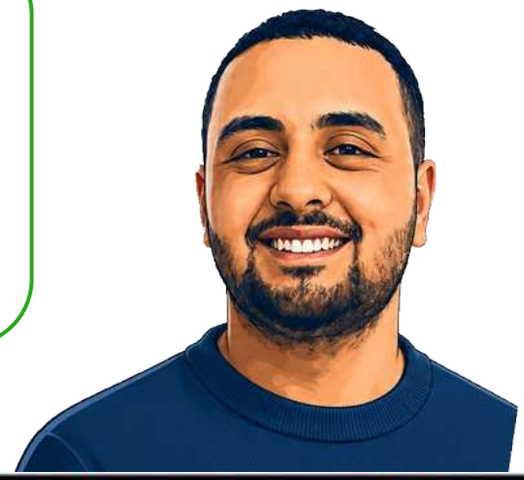

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موقع الدكتور محمد رزق التعليمي

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MR

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